MINIMIZATION AND MANAGEMENT OF CONSTRUCTION WASTE

Arya Muraleedharan[#1], Dr T R Sethuraman[#2],

[#1] *P G Student Construction Engineering and Management, Sivaji college of Engineering and Technology,* [#2]*Principal Sivaji college of Engineering and technology, Manivila, Kanyakumari district.Tamilnadu,India.*

aryamurali34@gmail.com

***Abstract*— Construction field has been developing day by day around the world. The development has led to a serious issue in generation of construction wastes in many developing countries. The construction wastes divided into physical and non-physical waste and it has greater impact to environment, economy and social of every country. This paper detects the factors that contributes to the generation of construction waste. The questionnaire survey will be carried out in many companiesfor the analysis. After completion of the survey, the results will be analyzed using SPSS software, reuse and recycling will be found and the mitigation measures will be provided. The result will help the construction players to avoid, reduce and recycle the physical and nonphysical wastes. otherwise, the paper has put forward some recommendations for better improvements in construction with reference to SMART- Waste Planning Tool (Waste Management policy assessment tool).**

***Key Words*—Waste Management, SPSS, SMART-Waste Planning Tool**

I. INTRODUCTION

Construction and demolition waste management has major environmental problems in many municipalities. It has become one of the been a serious issue in India since the late nineties due to the running out of disposal sites to manage the huge amount of waste generated. The building industry is consuming a large amount of resources, from the most common material sand to the valuable assets like timber. If the life cycle of the material on site, from its transportation and delivery to the end is closely examined, it is generally known that there is a relatively major portion of the materials being wasted because of poor material control on building sites. Construction waste is as any materials by product of human and industrial activity that has no residual value. Waste is a product or material that is unwanted and waste clustered into two groups namely the physical and non-physical waste. Physical construction waste is defined as waste which arises from construction, renovation and demolition activities including land excavation or formation, civil and building construction, site clearance, demolition activities, road work, and building renovation. However, some defined directly to solid waste: the inert waste which is mainly sand, bricks, blocks, steel, concrete debris, tiles, bamboo, plastics, glass, wood, paper, vegetation and other organic materials. construction debris can be seen in construction site. This type of waste consists of fully loss of materials, due to the fact that they are irreparably damaged or simply lost. The wastage commonly removed from the site to landfills. The Non-physical waste occurs during the construction process. By contrast with material waste, non-physical wastes are time and cost overrun for a construction project. Besides that, the waste can be considered as any inefficiency that results in the use of equipment, materials, labour and money in the construction process. In other words, waste in construction industry is not only focused on the quantity of materials on-site, but also overproduction, waiting time, material handling, inventories and unnecessary movement of workers.

II. LITERATURE REVIEW

Vivian W.Y. Tam et.al (2013): Construction solid waste has caused serious environmental problems.This paper examines rates of reusable and recyclable waste for six major types of building materials such as plastic, paper, timber, metal, glass and concrete. The rates of reusable and recyclable waste defined as ratios of actual reusable and recyclable material to the total construction waste. It is found that "metal" has the highest rate of reusable and recyclable waste and "plastic" has the lowest rate of reusable and recyclable waste.

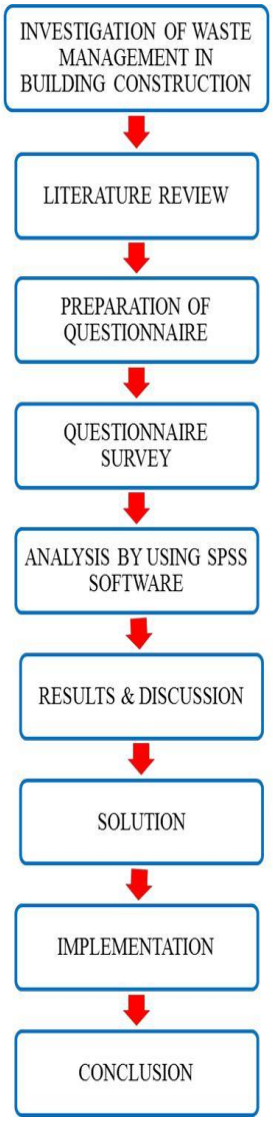
Ferry Firmawan et.al (2012): 'Lean Construction' (LC) concepts emerged as a consequence of the application of Value Engineering philosophy, specifically for construction industry. Lean construction extends from the objectives of a lean production system – to maximize value and to minimize waste – in relation to specific techniques and then applies them conceptually in a new project delivery process. This paper present practical examples of the application of Value Engineering and Lean Construction concepts within a green building construction project .

B.Sasidharani et.al (2015): The awareness among contractors and builders regarding waste minimization is still low although various research have proved the environment problems are getting more critical. This study is conducted to investigate the cause of waste, waste prevention method and the wastage level in construction site. There are three concepts to manage the waste. They are reduce, reuse and recycle (3R).Reduce is the most significant method for construction waste minimization.

Olusanjo O et.al (2014): The construction industry is traditionally environmentally unfriendly. There are various environmental impacts of construction waste which include soil contamination, water contamination, and deterioration of landscape. Also, construction waste has a negative economic impact which is that contributing additional cost to construction due to the need to replace wasted materials.

Ranchhod Mata et.al (2015): The construction industry is a major participant of the economy India. Construction waste gives various negative impact to the environment, costs, time, productivity and social of the country. To reduce these negativeimpacts, it needs a comprehensive understanding of the construction waste generation andmanagement.

III. METHODOLOGY



Questionnaire Survey

This study adopts questionnaire survey as a method to identify the underlying factors that causes wastage in construction. Survey through questionnaire is found effective because of the relative case of obtaining standard data appropriate for achieving the objectives of this study. The important questions that will contribute to the effective data collection and accurate results are prepared for the questionnaire. The questionnaire is prepared by referring journals and articles related to waste management. About 40 questions were prepared and then it is shortlisted to 30. The questions are made such that it can be easily understandable by the respondents. The questions are rating type questions so that more accurate results will be obtained.

- Initial
- Material Waste
- Secondary

One of the common scales in management attitude survey is Likert scale. In this study, to measure respondentsattitudes about the key factors in implementation of construction waste management, responses are measured over a range of five-point Likert scale of 1-5. These numerical values are assigned to the respondents rating:

5 = Extreme;
4 = Great;
3 = Moderate;
2 = Little; and
1 = None

In this study, SPSS software is used to classify and analyze the data.

- Analysis By Using Spss Software

The Statistical Package for the Social Sciences software ,developed by IBM and it is widely used to analyze data and make predictions based on specific collections of data. The implications of the results are fairly evident and are statistically valid. Using the SPSS software, one can conduct a series of studies quickly and effectively.

The six steps followed are:

I. Load the excel file with all the data.
II. Import the data into SPSS.
III. Give specific SPSS commands.
IV. Retrieve the results.
V. Analyze the graphs and charts.
VI. Postulate conclusions based on your analysis.

IV. RESULT AND DISCUSSION

According to the survey conducted, the first five major factors contributing to the waste in construction industries have been found out:

1. Poor planning and controlling
2. Demolition of building
3. Frequent design changes
4. Wrong material storage
5. Masonry and tile

The solution to the major five causes of construction wastes are suggested using the SMART-Waste Planning Tool. It is an online tool used as a means to reduce the amount of waste by tracking the waste produced in the construction sites. The tool gives the appropriate ways to rectify the produced waste. It also gives the list of materials that can be reused, reduced or recycled from a construction site. The first five factors contributing to the waste generation are uploaded in the SMART-Waste Planning Tool site. We should also enter the details of the area the survey was conducted. They track the wastage amount and also give the possible solutions to overcome the wastage.

There should be a proper planning from the initial stage of construction and control of the materials that are wasted after every construction activity. Make a detailed schedule on the material procurement, transportation, material handling, storage and usage of materials and a proper management system for controlling the waste produced. Most construction and demolition debris is generated at the project level and therefore subject to laws and regulations by local, state and federal laws. Management of construction and demolition waste is addressed at project, organization and disposition levels.

a. Project Level- Enhancing Project value and Performance

The project level includes the work of a specific project and is administered by the project team often led by the architect or engineer during the design phase. The project level requirements are communicated through project specifications and contract provisions. Green building certification programs include protocols, measurement and verification targets and documentation that may be helpful to ensure project goals are achieved.

b. Organization Level- Stewardship of Corporate Values and Priorities

The organization level includes the management of waste identified at the project level and includes the business practices and priorities of building owners and general contractors. The organization level provisions are communicated through corporate reports, policy statements and work plans.

c. Disposition Level- Management of Diversions and Disposal

This level includes the segregation, sorting, handling, transporting and final disposition of wastes and is administered by the businesses and agencies responsible for disposal under contract or agreement under licenses and in accordance with all laws and regulations. Communication is provided in the form of written diversion reports and tabulating the amounts of materials accepted, diverted and disposed and the locations of final disposition of materials received. Service providers at the disposition level can work with building owners and general contractors for project specific approaches to managing waste including custom diversion plans tailored to the project opportunities.

V. Demolition of building

There are many sound practices that could be put into effect on a construction or demolition site that would help reduce this impact. Many of the waste materials on construction sites can be disposed of following the three R: reduce, reuse, re-cycle. Recycling materials can generate income, save on costs and reduce your carbon footprint. Keeping a tidy site with reusable materials sorted and neatly stacked creates a safer working environment. Start reducing in the planning stages of a project, and craft designs so that there is less waste generated. Base designs on standard sizes and quantities to reduce cut-offs, and avoid over-ordering materials. Have safe and secure areas for storing materials and keeping them out of the weather. Quality workmanship will reduce the amount of errors and waste. Separate and store cut-offs so that they are easily accessible and can be used up first during construction. Frequent design changes

Wastage is also caused due to frequent variations in order by the clients or frequent changes in design during construction. Wastage due to frequent variation in order can be overcome by implementing some of the following remedies:

- Change of order is negotiated by knowledgeable persons
- Contract document are checked and reviewed
- The procedures for handling the change of orders are cleared from the beginning
- The scope of change orders is made clear
- Pricing of change orders considers indirect effects
- Freeze the design after a certain stage
- Changes are not made without appropriate approval in writing
- Reviewed for design before change approval
- Gray areas of contract documents are highlighted and reviewed before contract award
- Encourage team effort among all parties

- Areas of concern (monthly reports and meetings)
- Use of WBS (Work Breakdown Structure)
- Justification of change

VI. Wrong Material Storage

On site ,physical storage system vary according to the space availability and company practices. Industrial guidelines are also taken into consideration for stacking and storing of particular materials. The categories followed are civil, electrical, plumbing, finishes, construction chemicals, miscellaneous.

- The materials should not be affected by impurities or atmospheric gases.
- Materials like cement should be stored in covered sheds and stacked on timber raised platforms,
- Reinforcing bars should be stacked yards away from oil and moisture to prevent rusting also away from oil and lubricants.Different classification, sizes and lengths of bars should be stored separately to facilitate issues.
- Timber should be properly covered or else it may get wet and ne unusable for framing. Timber should be under a certain level of moisture before it can be used for flooring and framing.
- Get clear receipts to materials stored off site and have insurance coverage in case of any theft.
- Different types of bricks shall be stacked separately. Bricks of different strengths and sizes should be stacked separately.
- Steel of different classes should be stored separately. It should be stored in such a way so as to prevent deterioration and corrosion. Paint the end of the bars of each class in distinct colors.

VII. Masonry and tiles

We can reclaim undamaged bricks and blocks and use them in new building projects or sell them to other businesses which deal in reclaimed bricks.

By using these methods ,you can recycle damaged bricks and blocks:

- For making aggregate for use as general fill or highway sub-base
- in landscaping
- to produce new bricks and blocks
- For making sports surfaces such as tennis courts and athletics tracks
- as plant substrate

Making changes to the site operations one can make simple yet effective changes to the site's operations to reduce wastage and allow more waste to be recycled by:

- By providing storage areas to reduce damage during storage
- training staff in the handling of materials
- planning during the design stage to minimize the need for cutting bricks and blocks
- By separating the brick and block waste to avoid damage and contamination
- By using a lime-based mortar rather than a cement-based mortar - this allows the bricks to be recovered and reused at building deconstruction

The correct amount of tiles wasted during installation is around:

- to 10 per cent for wall and floor tiles
- 1 to 5 per cent waste for flooring tiles
- 5 to 10 per cent for rolls of flooring

The main causes of wastage from tiles and board include off-cuts, breakages and over ordering. Recovered tiles and board can be used in applications and materials including:

- reusing tiles as reclaimed materials
- recycling into aggregate
- producing mineral fibre acoustic ceiling tiles
- crushing bricks, tiles and using them for landfill works

VIII. CONCLUSION

- The aim of the study is to investigate the major causes of waste in the construction industry. After conducting questionnaire survey in various construction companies, the major factors responsible for waste production are identified using the Statistical Package for Social Sciences analysis. The recommended actions will be considered into account and the improvement activities are executed by using SMART – Waste Planning Tool. And it is hoped that, implementation of SMART Tool leads to a reduction in the amount of waste coming from construction industries. The solutions or recommendations are given based on reference to the tool and reference companies.As environmental protection has been pressing hard around the world, pollution generation from construction activities seems cannot be controlled. 3R - Reusing, recycling and reducing construction materials have been encouraged and suggested for the practices in

construction activities. Recommendations on reusing, recycling and reducing construction materials are also been discussed. Companies needs an innovative in their use of recycled materials and reduce their dependency on raw materials and more data and better documentations are needed to encourage the use of waste and recycled materials in the construction industry.

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